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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant	:	Neil G. Murray Jr. et al.
Serial No.	:	10/767,798
Filing Date	:	January 29, 2004
For	:	METHOD FOR MONITORING QUALITY OF A TRANSMISSIVE LASER WELD
Group Art Unit	:	2859
Examiner	:	G. K. Verbitsky
Attorney Docket No.	:	TRW(TE)6888

Mail Stop Reply Brief - Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

REPLY BRIEF

Sir:

This Reply Brief is in response to the Examiner's Answer dated April 1, 2009. This Reply Brief addresses the grounds of rejection set forth in section (9) of the Examiner's Answer and the response to arguments in section (10) of the Examiner's Answer.

Claim 1

The combination of Messler and Juret does not teach or suggest all the limitations of claim 1.

Claim 1 recites the step of obtaining a thermal image as a weld is being formed by collecting infrared radiation passing through a second piece of material from the weld and a pool of material.

Messler teaches that a pyrometer 58 detects the thermal radiation 60 emitted by the weld at the melt 48, i.e. the unsolidified portion or pool of the weld seam 15 (Fig. 6). The solidified weld seam 15 or weld, on the other hand, is inspected by inspection radiation 30, whose exit radiation 33, 33' from an inspection point 57 on the weld 15 is detected by a detector 55 (Col. 7, lines 1-3 and Fig. 2). It is thereby clear that the inspection radiation 30 inspects only the solidified weld seam 15 and the pyrometer 58 inspects only the unsolidified melt 48. This is the case whether the inspection occurs during welding or at a time following welding in which only the weld seam 15 exists and, only inspection radiation 30, such as the last radiation 20, is used (Col. 5, line 64 – Col. 6, line 2). The inspection radiation 30 is therefore completely independent of the thermal radiation emanating from the unsolidified portion of the weld seam (Col. 5, lines 36-38).

The Examiner asserts in the Examiner's Answer that thermal radiation is also obtained by the CCD camera 39, as shown in Fig. 5, by collecting radiation from the pool of material and the weld (Examiner's Answer page 11). A CCD (charge coupled device) camera, however, detects optical brightness - not thermal radiation. The disclosure of Messler reflects this distinction:

> Next to the workpiece 10, there is a source 31 for *electromagnetic radiation 30, which is independent of the laser beam 20* (Col. 4, lines 33-36) (emphasis added).
>
> [A]s Fig. 5 illustrates, several radiation sources 31 can be used. In Fig. 5, the inspection radiation 30 is directed at the workpiece 10 from all sides. Depending on the quality of the weld seam 15, there are differences in the radiation 33 exiting the workpiece 10. In Fig. 5, *this radiation 33 is detected by a CCD camera 39*, which receives an image of the weld seam 15 (Col. 5, lines 51-57) (emphasis added).

In other words, the CCD camera 39 only detects the radiation 33 originating from the electromagnetic radiation 30 that, as noted, is completely independent of the thermal radiation emanating from the unsolidified portion of the weld. The CCD camera 39 does not, therefore, obtain or collect thermal radiation from the pool of material and the weld as asserted by the Examiner.

The Examiner further asserts that the measures of infrared radiation, i.e., the inspection radiation 30 and the pyrometer 58, can be used simultaneously during the welding operation (Examiner's Answer page 11). This allegation does not render claim 1 unpatentable because no matter when the inspection radiation and the pyrometer are used – before, during or after welding, in sequence or simultaneously – the weld pool is only inspected with thermal radiation and the solid weld is only inspected with inspection radiation that is completely independent of the thermal radiation. In other words, thermal radiation is never used to inspect both the weld pool and the solid weld.

For these reasons, Messler does not teach obtaining a thermal image as a weld is being formed by collecting infrared radiation passing through a second piece of material from the weld and a pool of material.

The Examiner relies on Juret for the teaching of providing a thermal image. Juret is related to an IR camera 6 that is designed to provide thermal images of certain locations in relation to the fusion zone of two metal plates being welded together end-to-end. This profile, however, is not directed at a weld and a pool of material. Rather, an IR camera 6 may observe a zone disposed immediately ahead of the advancing fusion zone, or a zone providing a thermal image at the fused metal, or a zone behind the advancing fusion zone (Col. 5, lines 6-13 and Fig. 2A). None of these zones capture thermal images of a weld and a pool of material, as recited in claim 1. Thus, Juret does not cure the deficiencies of Messler. Since the combination of Messler and Juret does not teach the subject matter of claim 1, it is respectfully submitted that claim 1 is patentable over the combination of Messler and Juret and is therefore allowable.

Claims 4-8, 12, and 26-32 depend from claim 1 and are allowable for at least the same reasons as claim 1 and for the specific limitations recited therein.

Claim 2

The combination of Messler and Juret does not teach or suggest all the limitations of claim 2.

Claim 2 recites the step of obtaining a thermal image that includes, in its entirety, a weld pool that results in a weld. Neither Messler nor Juret taken either alone or in combination disclose or suggest this feature. In Messler, the pyrometer 58 detects only the thermal radiation of a portion of the melt 48 and not an entire weld pool that results in a weld. Furthermore, as noted, the CCD camera 39 only detects the radiation 33 originating from the electromagnetic radiation 30 that is

completely independent of the thermal radiation emanating from the unsolidified portion of the weld.

Juret does not cure the deficiencies of Messler. As noted, the profile of the IR camera 6 in Juret includes only the fused metal and is not configured to have a field of view which includes an entire weld pool. Thus, Juret does not teach obtaining a thermal image that includes, in its entirety, a weld pool that results in a weld. Since the combination of Messler and Juret does not teach the subject matter of claim 2, it is respectfully submitted that claim 2 is patentable over the combination of Messler and Juret and is therefore allowable.

Claim 3

The combination of Messler and Juret does not teach or suggest all the limitations of claim 3.

Claim 3 recites the step of positioning an infrared detector in a location in which a weld pool in its entirety is within a field of view of the infrared detector. As noted, the CCD camera 39 in Messler detects optical brightness, not thermal radiation, and Juret teaches an IR camera having a field of view that does not include an entire weld pool. Thus, the combination of Messler and Juret does not teach positioning an infrared detector in a location in which a weld pool in its entirety is within a field of view of an infrared detector. Since the combination of Messler and Juret does not teach the subject matter of claim 3, it is respectfully submitted that claim 3 is patentable over the combination of Messler and Juret and is therefore allowable.

Claim 13

The combination of Messler and Juret does not teach or suggest all the limitations of claim 13 because 1) claim 13 requires directing the laser beam over the same points on the path of a weld pool multiple times and 2) the art of record does not teach or suggest this step.

Claim 13 recites the step of heating first and second plastic pieces by directing a laser beam over a path of a weld pool multiple times to form a pool of material. Simultaneously with the heating step, a thermal image is obtained as a weld is being formed between the first plastic piece and the second plastic piece. The Examiner asserts that claim 13 does not require that the laser be directed over the same points on the path multiple times because the limitation is not stated in claim 13 (Examiner's Answer page 12). The Applicants disagree.

During patent examination, the pending claims must be given the broadest reasonable interpretation consistent with the specification. *In re Prater*, 415 F. 2d 1393, 162 U.S.P.Q. 541 (C.C.P.A. 1969). The Applicants respectfully submit that it appears the Examiner is ignoring the Specification in interpreting and thereby rejecting claim 13. As disclosed in the Specification of the present invention:

> When forming weld pool 60, the weld controller 46 may control the mirror adjustment surface 44 so that the mirror 42 directs the beam 50 of electromagnetic energy over the path of weld pool 60 multiple times. *For example, with reference to Fig. 2, the beam 50 of electromagnetic energy may start in the upper, right corner of the weld pool 60, as viewed in Fig. 2, and may be moved around the generally square-shaped path in a clockwise direction multiple times.* By moving the beam 50 of electromagnetic energy around the path of weld pool 60 multiple times, a more uniform heating of the weld pool 60 occurs and the entire weld 56 may be formed simultaneously.

(Page 11, lines 1-13) (emphasis added). Accordingly, one having ordinary skill, having read the aforementioned portion of the Specification, would readily

understand that claim 13 requires that the beam 50 is directed over the same points on the path multiple times. This beam directing is not equivalent to a plurality of short applications of a beam, as the Examiner asserts.

In fact, Messler specifically teaches not directing the laser beam over the path of a weld pool multiple times. In particular, during movement of the workpiece 10 relative to the processing head 50, the focus moves along the workpiece, and the melt gradually undergoes solidification 49. The weld seam 15 forms in this way (Col. 6, lines 26-31). Thus, the laser beam is directed over the path, where the weld seam is formed, only once and not multiple times. The head 50 does not, for example, return to the start of the weld 15 and re-trace the same weld path to form the weld 15. Accordingly, Messler does not teach or suggest directing a laser beam over the path of a weld pool multiple times.

Juret discloses that the frame member 5 has a beam-generator 3 for providing a high-energy beam 4 to weld two plates. The frame member 5 moves from left to right during welding of the plates. Juret fails to disclose or suggest directing the beam 4 over a path of a weld pool multiple times and, thus, does not cure the deficiencies of Messler.

The combination of Messler and Juret further also fails to teach the step of obtaining a thermal image by collecting infrared radiation within a determined range of wavelengths from a weld and a pool of material. As noted, Messler teaches that a pyrometer 58 uses thermal radiation to image only an unsolidified weld melt 48 and a detector 55 uses electromagnetic radiation 30 to image only a solidified weld seam 15. Thus, Messler does not teach obtaining a thermal image by collecting

infrared radiation within a determined range of wavelengths from a weld and a pool of material.

Juret does not cure the deficiencies of Messler, as Juret teaches thermal imaging only of a fused metal zone and not obtaining a thermal image of a weld and a pool of material, as recited in claim 13. For these reasons, the combination of Messler and Juret does not teach the subject matter of claim 13. Accordingly, it is respectfully submitted that claim 13 is patentable over the combination of Messler and Juret and is therefore allowable.

Claims 15-21 and 24 depend from claim 13 and are allowable for at least the same reasons as claim 13 and for the specific limitations recited therein.

Claim 14

The combination of Messler and Juret does not teach or suggest all the limitations of claim 14.

Claim 14 recites the step of obtaining a thermal image that includes, in its entirety, the weld pool that results in a weld. As noted, the combination of Messler and Juret does not teach this subject matter. Thus, it is respectfully submitted that claim 14 is patentable over the combination of Messler and Juret and is therefore allowable.

Claim 25

The combination of Messler and Juret does not teach or suggest all the limitations of claim 25 because 1) claim 25 requires directing the laser beam over the same points on the path of a weld pool multiple times and 2) the art of record does not teach or suggest this step.

Claim 25 recites the step of heating the first and second pieces at their location of abutment to form a pool of material at the location of abutment which pool

of material forms a weld between the pieces is performed by directing the laser beam over the path of the weld pool multiple times. Modifying occurs during directing of the laser beam over the path during at least one of said multiple times. Neither Messler nor Juret disclose or suggest this feature.

As noted, the recitation of directing the laser beam over the path of the weld pool multiple times requires that the laser beam be directed over the same points on the path multiple times, and neither Messler nor Juret, taken alone or in combination, teach or suggest this step. Accordingly, it is respectfully submitted that claim 25 is patentable over the combination of Messler and Juret and is therefore allowable.

Claim 33

The combination of Messler and Juret does not teach or suggest all the limitations of claim 33, and Shepard does not cure the deficiencies of Messler and Juret because Shepard teaches away from stopping the obtaining of any thermal images of a formed sample after the weld is formed.

Claim 33 recites the step of obtaining a plurality of thermal images as the weld is being formed and stopping the obtaining of any thermal images of the weld after the weld is formed. The Examiner acknowledges that Messler and Juret do not teach or suggest this step, but asserts that Shepard cures the deficiencies of Messler and Juret.

Shepard does not disclose stopping the obtaining of thermal images of the weld after the weld is formed. The Examiner asserts that Shepard inherently has a power button for turning the device on/off when necessary, and that common sense dictates stopping taking measurements or using the equipment when the operation is completed (Examiner's Answer page 13). The Applicants disagree.

The step of using the power button to stop the obtaining of any thermal images of a formed sample is not "necessarily present" in the device of Shepard. Quite the contrary, the abstract of Shepard discloses the use of an infrared camera to capture multiple, spatially different images of a sample that has been heated and allowed to cool to equilibrium temperature. This explicitly indicates that a thermal image is taken after a sample is formed and allowed to cool.

In the present application, the pool of material cools sufficiently to solidify and become the weld well before the first and second plastic pieces return to thermal equilibrium. Thus, since there are no thermal images obtained after the weld is formed, there are no thermal images taken from the point at which the weld forms until the pieces return to thermal equilibrium. This is clearly in contrast to Shepard, where thermal images are obtained over the range of time during which the sample temperature returns to equilibrium (Paragraph 63).

The Examiner asserts that Shepard teaches stopping taking images after the weld is done and after the weld is cooled (Examiner's Answer page 13). Shepard, however, clearly teaches away from stopping the obtaining of thermal images after the weld is done but before the weld has cooled. In particular, Shepard relies on the entire thermodynamic profile of the weld during the time the weld is formed and cools. A temperature versus time correlation is plotted to represent the weld temperature during formation and cooling (*see* Figs. 3A and 3B). The data generated by the plot is fitted to a low order polynomial and thereafter manipulated mathematically in order to detect surface defects (Paragraphs 69-73). Therefore, if the power button is used to cease thermal imaging acquisition prior to the weld

completely cooling, as the Examiner suggests, significant portions of the temperature versus time plot would be absent and, thus, the crucial polynomial fit used to ultimately assess weld surface defects would be inaccurate. For these reasons, one having ordinary skill would readily understand Shepard as requiring the acquisition of thermal images during the entire formation and cooling of the weld in order to accurately assess surface defects of the weld.

Accordingly, Shepard does not teach stopping the obtaining of thermal images of a weld after the weld is formed and, therefore, does not cure the deficiencies of Messler and Juret. Since the combination of Messler, Juret and Shepard does not teach the subject matter of claim 33, it is respectfully submitted that claim 33 is patentable over the art of record and is therefore allowable.

Claim 34

The combination of Messler and Juret does not teach or suggest all the limitations of claim 34, and Shepard does not cure the deficiencies of Messler and Juret because Shepard teaches away from stopping the obtaining of any thermal images of a formed sample after the weld is formed.

Claim 34 recites the step of obtaining a plurality of thermal images as the weld is being formed and stopping the obtaining of any thermal images of the weld after the weld is formed. The Examiner acknowledges that Messler and Juret do not teach obtaining a plurality of images and stopping the obtaining of any thermal images of a weld after the weld is formed. The Examiner asserts, however, that Shepard cures the deficiencies of Messler and Juret. As noted, the combination of Messler, Juret and Shepard does not teach the step of obtaining a plurality of thermal images as the weld is being formed and stopping the obtaining of any

thermal images of the weld after the weld is formed. Accordingly, it is respectfully submitted that claim 34 is patentable over the combination of Messler, Juret and Shepard and is therefore allowable.

Claim 35

Claim 35 recites that the path is a closed-curved shape, and wherein the step of heating the first and second pieces at their location of abutment to form a pool of material at the location of abutment which pool of material forms a weld between the pieces is performed by directing the laser beam around the path of the weld pool multiple times. Modifying occurs during directing of the laser beam around the path during at least one of the multiple times. None of the cited references disclose or suggest this feature. In fact, the Final Office Action, the Advisory Action, and the Examiner's Answer fail to cite any reference or even any reason to reject claim 35. Therefore, claim 35 is allowable.

Claim 36

Claim 36 recites that the path is a closed-curved shape, and wherein the step of heating the first and second plastic pieces at their location of abutment is performed by directing the laser beam around the path of a weld pool multiple times to form a pool of material at their location of abutment which pool of material forms a weld between the pieces. None of the cited references disclose or suggest this feature. In fact, the Final Office Action, the Advisory Action, and the Examiner's Answer fail to cite any reference or even any reason to reject claim 36. Therefore, claim 36 is allowable.

In view of the foregoing, Appellants respectfully submit that the rejections of claims 1-8, 12-21, and 24-36 are improper and should be reversed. Reversal of the rejections of claims 1-8, 12-21, and 24-36 is respectfully requested.

Please charge any deficiency or credit any overpayment in the fees for this Reply Brief to our Deposit Account No. 20-0090.

Respectfully submitted,

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